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EP 0406994 A1

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(54) Abstract Title

Air extraction from a power generation turbine

(57) Power generation apparatus includes air separation unit 5 producing an oxygen enriched product for supply to gasification vessel 3 which produces fuel gas by the partial oxidation of a carboniferous feedstock; a generator 20 driven by gas turbine 1 comprising air compressor 11, means for delivering a portion of compressed air to combustor 13 and expander 12 driven by combustion products from the combustor 13 and driving the compressor 11. The remaining portion of compressed air is extracted from the gas turbine 1, and may be used in expander 4 to drive generator 41. None of the remaining portion of air is feed to the air separation unit.

A Clean Power Generation (CPG) facility is described (fig 4) and alternative air extraction arrangements taught (figs 5 and 6).

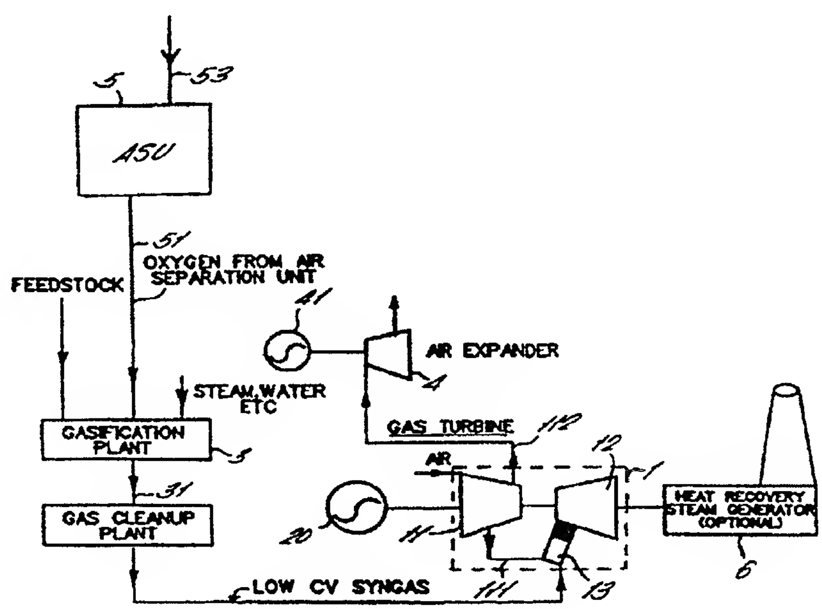

FIGURE 2

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

PRIOR ART

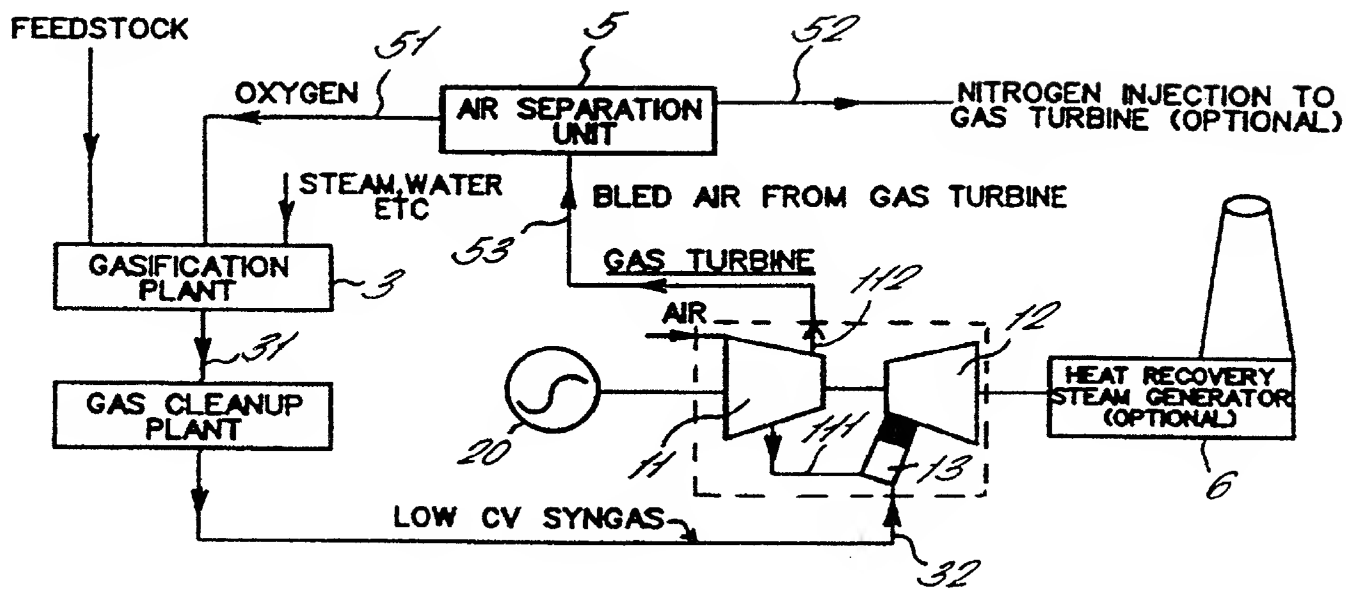

FIGURE 1

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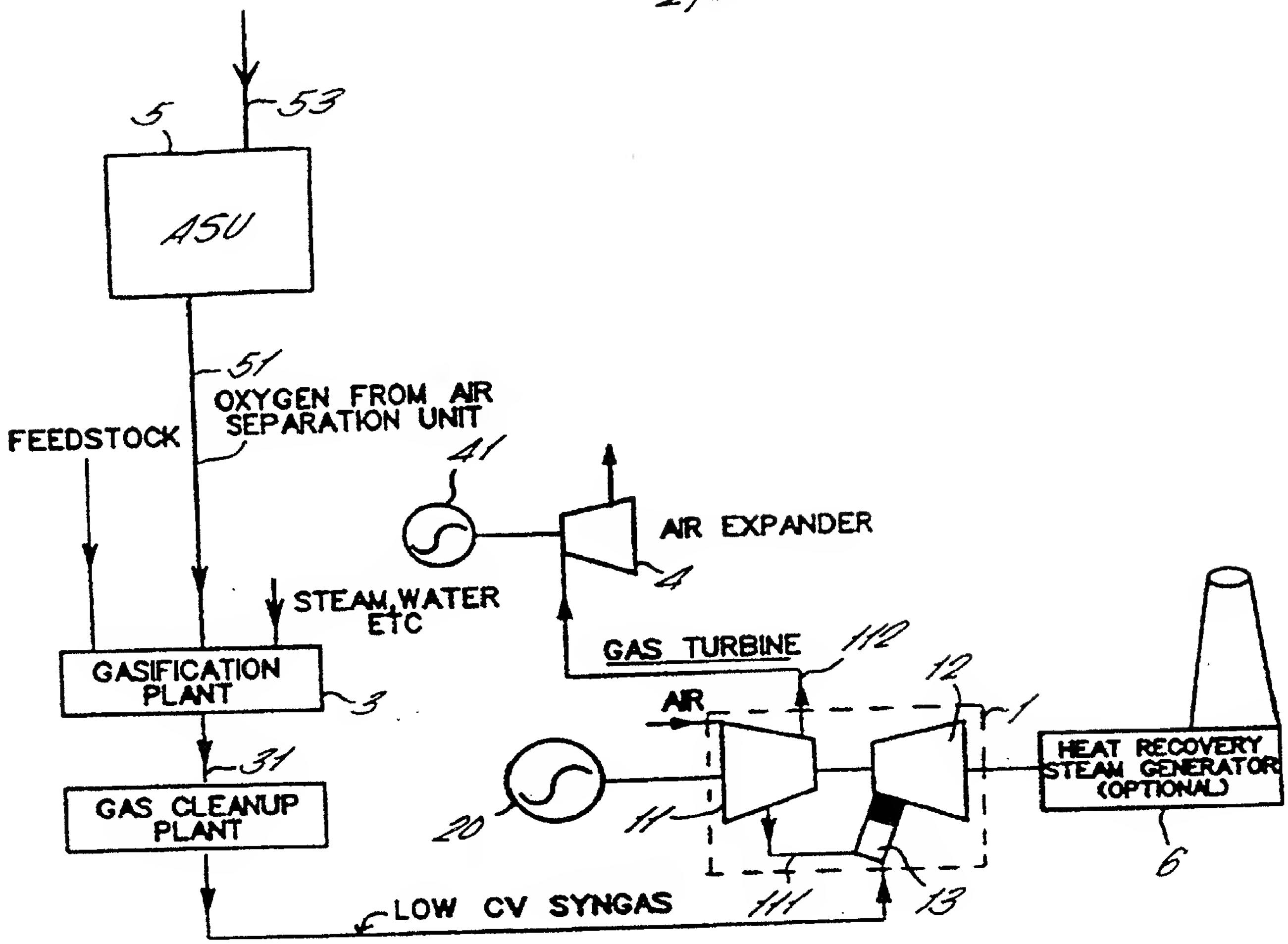
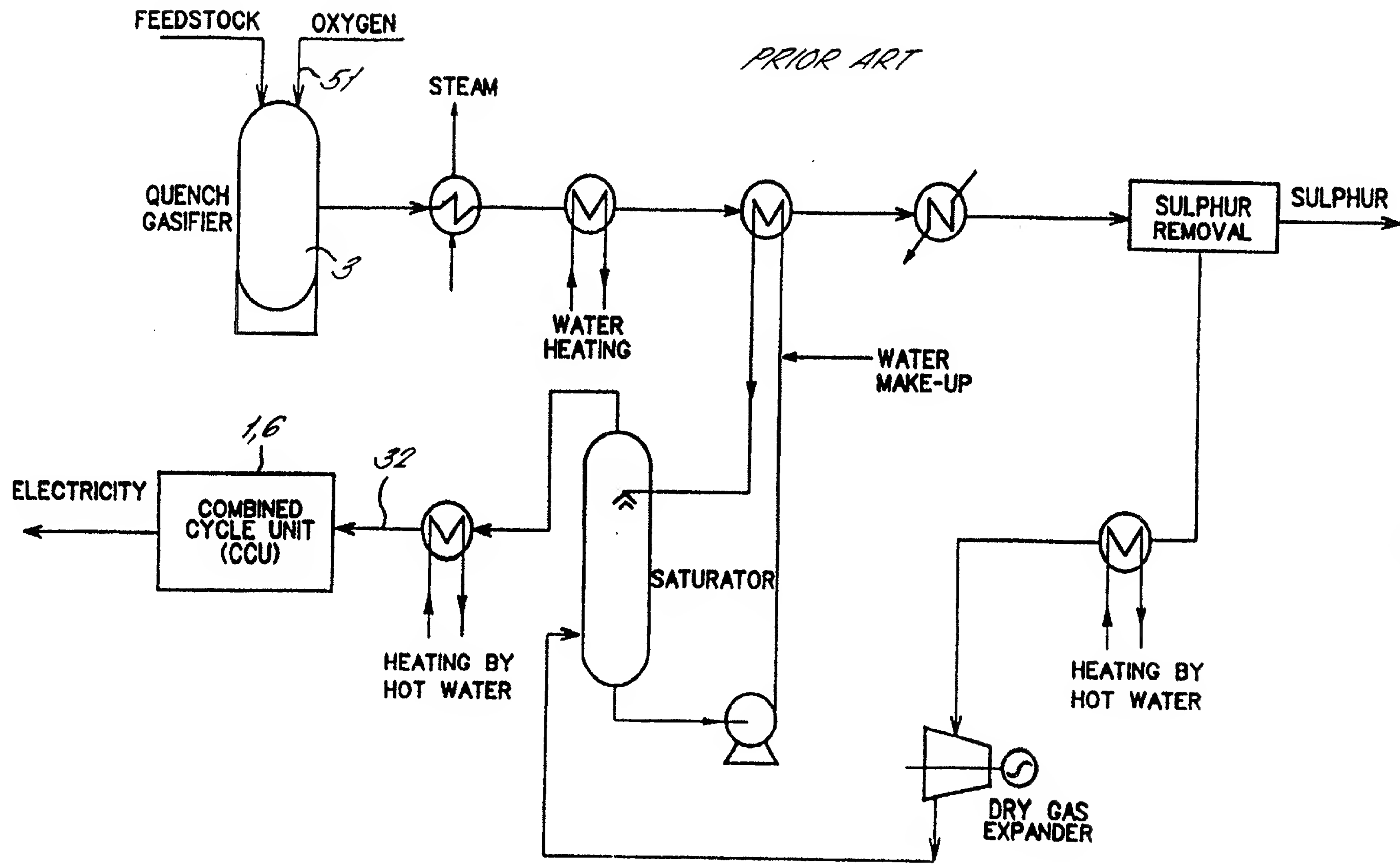
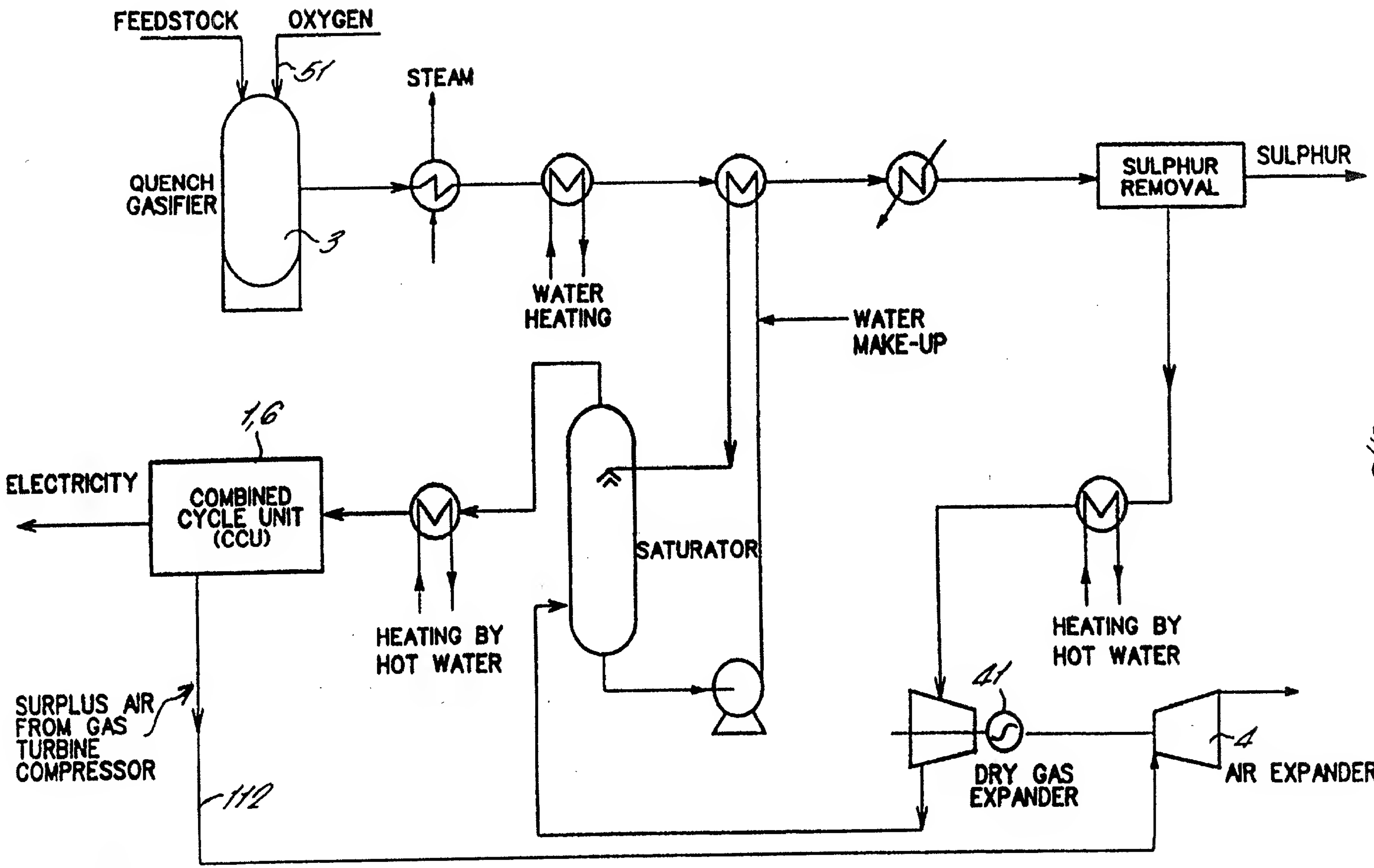


53
5
ASU
51
OXYGEN FROM AIR SEPARATION UNIT
FEEDSTOCK
41
AIR EXPANDER
4
STEAM,WATER ETC
GAS TURBINE
112
GASIFICATION PLANT
3
12
AIR
1
31
HEAT RECOVERY STEAM GENERATOR (OPTIONAL)
GAS CLEANUP PLANT
20
11
6
LOW CV SYNGAS
111
13

FIGURE 2



SIMPLE CLEAN POWER GENERATION
FIGURE 3



SIMPLE CLEAN POWER GENERATION - WITH " SURPLUS AIR" EXPANDER

FIGURE 4

FIGURE 5

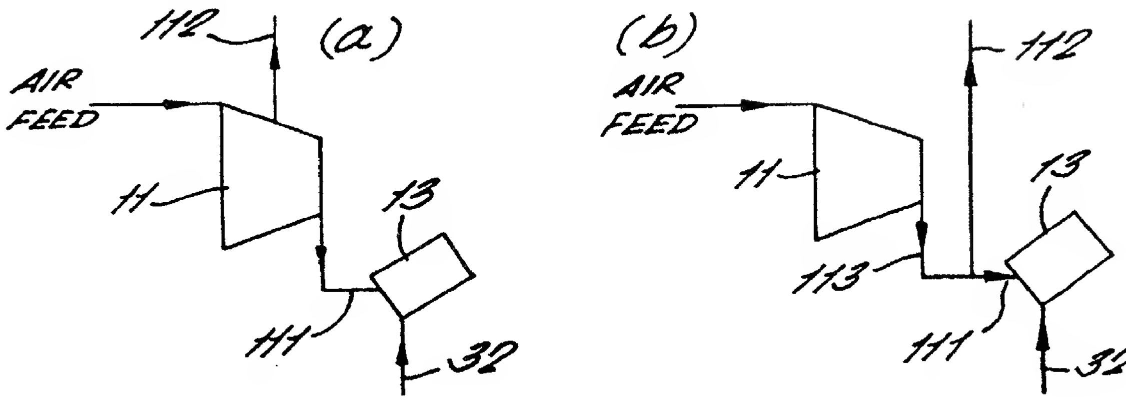
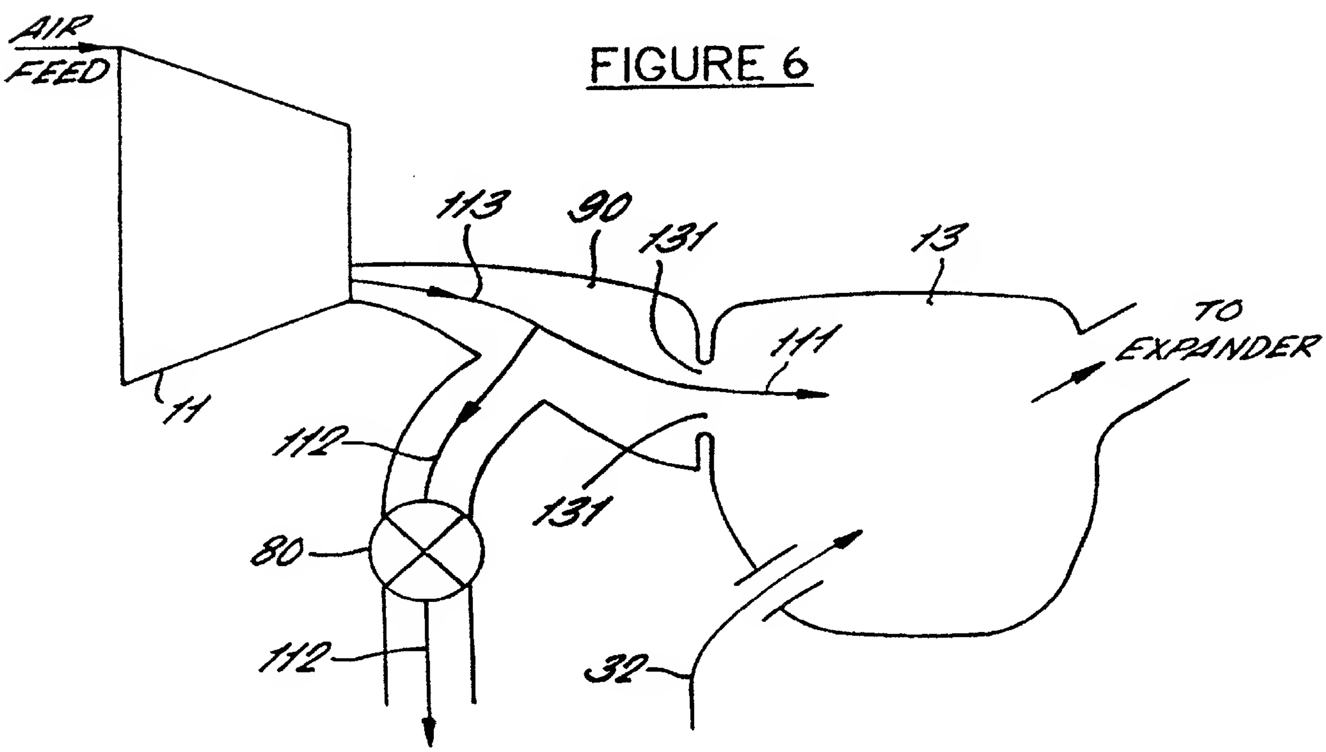


FIGURE 6



POWER GENERATION APPARATUS AND METHOD

The present invention relates to power generation apparatus, and in particular, although not exclusively, to Gasification Combined Cycle power generation apparatus.

Gasification power generation facilities in which fuel gas is produced by the gasification of a carboniferous feedstock such as coal, and combusted and expanded in a gas turbine arranged to drive a generator are well known. The oxygen required for the partial oxidisation of the feedstock in the gasification process is typically provided from an air separation unit. The air separation unit typically requires a feed of compressed air, and from this feed produces oxygen-rich and nitrogen-rich product streams. A variety of air separation processes are known, including adsorption, cryogenic, membrane and chemical absorption.

In Gasification Combined Cycle power generation facilities the hot exhaust gases from the gas turbine expander are used to raise steam, which in turn is used to generate more power, thereby increasing the overall efficiency of the process. In advanced Gasification Combined Cycle (GCC) power generation facilities the fuel gas from the gasifier is cleaned before combustion, and may also be saturated to cool the combustor flame and reduce nitrogen-oxide (NOx) emissions. The flame may also be cooled by the injection of nitrogen from the air separation unit into the combustor or into the fuel supply.

When choosing a gas turbine for use in a gasification power generation facility, the plant designer is faced with numerous designs nominally intended for use with other fuels, such as natural

gas, having higher calorific values than the "synthesis gas" or "syn-gas" produced in the gasification process. In each design, the compressor stage of the gas turbine and the compressed air inlets to the combustor will be arranged to provide an appropriate amount of compressed air into the combustor for a given rate of fuel consumption (and hence power output) for complete combustion of the fuel and for flame cooling. For a given power output and fuel calorific value, the amount of compressed air required for flame cooling depends on the expander blade material, blade coatings, and any blade internal cooling arrangements. Flame cooling is necessary because, in spite of advances in blade materials and in blade cooling technology, the expander section of modern gas turbines would still suffer distress as a result of the heat of the combustor flame, were measures not taken to reduce the temperature of the gases reaching it. This means that if a gas turbine nominally designed for operation with a fuel gas of higher calorific value is employed in gasification power generation apparatus, the potential exists for the compressor to deliver, or attempt to deliver, a surplus of air, ie. more air than is required for combustion and flame cooling. The reason for this is that for the same gas turbine power output, and fuel supply pressure, a greater mass flow of lower calorific value fuel gas is required, and this increased mass flow of fuel gas itself provides some of the flame cooling requirements. This surplus of air can be thought of as being a result of a mismatch between the compressor output capability and the air feed requirements of the combustor.

The mismatch may result in surplus air entering the combustor and lowering the flame temperature below

its optimum value. This is a particular problem in GCC applications where the flame temperature should be as high as possible (taking into account the expander blade properties) to maximise the efficiency of the power generation process from the hot combustion gases.

The mismatch may, in addition, or alternatively, result in "stagnation" of compressed air between the compressor discharge and the combustor air inlet. This situation arises when the compressor tries to push more air through the combustor air inlet than its design, coupled with the pressure difference across it, will allow, and may cause a pressure increase at the compressor discharge. If the compressor has a sufficient surge margin this stagnation or pressure increase may be tolerated, but will lead to reduced compressor efficiency, and undesirable heating of the stagnant air as the compressor blades cause turbulence.

If the surge margin of the compressor is insufficient, the surplus air may in fact choke or stall the compressor.

Surge is defined as the lower limit of stable operation in a compressor and involves the reversal of flow. The surge margin is the capability of the compressor to accommodate this.

When "high calorific value fuel" gas turbine designs are used in GCC applications, the surplus air problem caused by the lower calorific value syn-gas is made worse if the syn-gas is saturated prior to combustion, or if nitrogen is injected into the combustor or the fuel supply stream. Both saturation and nitrogen injection can be thought of as "diluting" the fuel gas, further reducing its effective calorific value.

When designing a gasification power generation plant, the above problems can be addressed in a number of ways.

Firstly, a compressor nominally designed for operation with a higher calorific value fuel can be chosen which has an adequate surge margin, such that all, or at least a large portion of, the excess (i.e. surplus) air can be "swallowed" without stalling the compressor. However, disadvantages of this approach are that the compressor runs at reduced efficiency, and some surplus air may still enter the combustor and reduce the flame temperature. In addition, this approach limits the choice of gas turbine for the designer as the compressors in modern, high efficiency gas turbines tend to have smaller surge margins than older designs. Unless the modern gas turbine has been specifically designed or adapted for syn-gas operation, the small surge margin means that the surplus air will choke or stall the compressor.

Secondly, a gas turbine designed for operation with a higher calorific value fuel can again be chosen, and its compressor modified (eg. by the omission of a stage of the blades) so that it delivers a lesser amount of compressed air to the combustor. However, modified gas turbine compressor stages can again reduce choice and limit flexibility, and also increase the cost of the plant.

Thirdly, a well known technique in the past has been to extract some of the surplus compressed air and use it to supply some or all of the air separation unit compressed air feed requirement. The air separation process requires a compressed air supply, and so using excess air already compressed by the gas turbine compressor increases the overall efficiency of the plant. A typical arrangement is shown in Fig. 1,

where the extracted air 112 from the gas turbine 1 supplies all of the compressed air feed to the air separation unit 5. This is known as full air integration.

In alternative arrangements, the extracted air may supply just part of the air separation unit requirement, the remainder coming from a dedicated independent compressor. This is known as partial air integration.

Nitrogen from the air separation unit may be injected into the gas turbine to reduce flame temperature and reduce NOx emissions, and this is known as nitrogen integration. Air and nitrogen integration can be employed together.

GCC systems in which the air separation unit is in some way integrated with the gas turbine (i.e. receiving air from it, or supplying a nitrogen product to it) are known as Integrated Gasification Combined Cycle (IGCC)systems. Examples of such systems are described in US 5406786, EP 0773416A2 and US 5666823.

Although air integration, in general improves the overall plant efficiency, it has the disadvantages that it increases the complexity of the plant design and control (which can therefore increase cost), it reduces the ease of operation of the plant, and, perhaps most importantly, it reduces flexibility, especially the flexibility of response to increases in power output demand from the gas turbine.

Ideally, one would like to have independent control of the air pressure and volumetric flow (and hence mass flow) to the air separation unit, ie. it should be unaffected by the operation of the gas turbine. This in turn makes the rate of fuel production independent. Supplying the air separation unit with extracted air removes this independence. A

particularly serious problem is encountered in integrated air systems when rapid increases in power output from the gas turbine are required. In response to a rapid demand increase, the fuel supply control valve is opened to allow an increased flow of fuel gas into the combustor, and guide vanes at the air inlet to the gas turbine compressor are controlled to allow more air to enter the compressor and so enable it to deliver an increased compressed air supply to the combustor. These changes affect the pressure and volumetric flow of extracted air, and hence affect the compressed air supply to the air separation unit.

This can lead to a reduction in the rate of oxygen production from the air separation unit, at a time when more oxygen is required for the gasification process to increase the rate of fuel gas production and sustain the increased power output. The rate of nitrogen production from the air separation unit may also decrease, and is an additional problem if the plant is nitrogen integrated, as, for increased power output, an increased flow rate of nitrogen into the combustor is required for flame cooling.

An attempt to respond to a rapid increase in power demand can result in a reduction in the mass flow of extracted air to the air separation unit (ASU) and can reduce the mass flow of the oxygen-enriched product. Increases in the pressure of extracted air mass also reduce the rate of oxygen production if they cause the feed pressure to the ASU to move away from an optimum value.

In an attempt to increase the response time of the gas turbine in air integrated systems, a known technique is to reduce or throttle the air extraction in response to power output demand increases. A greater proportion of the compressed air produced by

the compressor is, therefore, made available to the combustor. However, reducing the amount of air extracted reduces the supply to the air separation unit, leading to a decrease in the rate of fuel production when an increase is in fact required.

It is known to use additional expanders and/or compressors to try to match the extracted air to the feed requirements of the air separation unit. However, this increases plant design and control complexity.

The above problems mean that, in general, the response of an air integrated gasification power generation system to changes in demand is slow, and plant control and operation at anything other than constant power output is difficult.

According to a first aspect of the present invention there is provided power generation apparatus comprising:

a generator;

a gas turbine comprising a combustor, a compressor having an air feed and being operable to produce compressed air from said air feed, means for delivering a portion of said compressed air into the combustor, and an expander arranged to receive hot combustion products from the combustor and to drive the compressor and the generator with work produced from the expansion of the hot combustion products;

extraction means for extracting from the gas turbine a remaining portion of said compressed air;

fuel gas supply means for supplying fuel gas to the combustor, including a gasification vessel inside which fuel gas is produced by the partial oxidation of a carboniferous feedstock;

an air separation unit operable to produce an oxygen-enriched product from a compressed air feed and

arranged to supply at least a portion of said oxygen-enriched product to the gasification vessel for said partial oxidisation; and

air compression means, independent of the gas turbine compressor, arranged to provide said compressed air feed to the air separation unit,

the power generation apparatus comprising no means for feeding compressed air extracted from the gas turbine to the air separation unit.

Thus, rather than being delivered into the combustor or "stagnating" between the compressor discharge and the air inlet to the combustor, a portion of the air compressed by the compressor can be directly extracted from the gas turbine. The extracted portion is not fed to the air separation unit. Deliberately, no means are provided for feeding the extracted air to the air separation unit in order to keep the compressed air feed independent of the operation of the gas turbine compressor at all times.

Advantages of the present invention include:

1. Extracting portion of the compressed air produced by the gas turbine compressor enables the flow of air into the combustor to be reduced. This reduces flame cooling and increases the temperature of combustion products. This is particularly advantageous in GCC systems, where the flame temperature should be as high as possible to give maximum efficiency, in which the gas turbine compressor would otherwise deliver a surplus of air into the combustor.

2. Extracting compressed air upstream of the combustor air inlet can reduce stagnation at the compressor discharge, reduce pressure, prevent excessive heating of air supplied into the combustor, and allow the compressor to operate at its optimum

design efficiency. This is particularly advantageous in arrangements where there is a large mismatch between the air flow into the combustor and the nominal output of the compressor, and can prevent the compressor from choking or stalling.

3. The present invention increases flexibility in the design of the gasification power generation apparatus. Gas turbines nominally designed for other fuel supplies (with higher calorific values than the syn-gas mixture combusted in the combustor of the present invention) can be used which would otherwise have resulted in unacceptably low flame temperatures, low compressor efficiencies, or excessive heating, or which would otherwise have choked or stalled, because of a mismatch between their compressor output capability and the compressed air flow requirements of the combustor. In particular, the present invention enables modern gas turbines with very high efficiency compressors having low surge margins to be used in gasification power generation apparatus, provided that the combustors are designed to take the lower calorific value (cv) gas.

4. The present invention provides simplified plant design and control. Plant structure and design is simplified as the extracted air is not fed to the air separation unit, and there is no need to try to match the extracted air to the feed requirements of the air separation unit. Control is simplified as the compressed air feed to the air separation unit is completely independent of the operation of the gas turbine and the pressure and quantity of extracted air.

5. The present invention provides increased operational flexibility as the compressed air feed to the air separation unit, and hence the production of

the synthetic fuel gas, is at all times completely independent of the operation of the gas turbine. This increased operational flexibility includes faster response to increases in power output demand, as the compressed air feed to the air separation unit can be quickly and independently increased. The air separation unit feed is unaffected by changes in the amount of pressure of air extracted from the gas turbine resulting from throttle changes or changes in load.

The present invention offers improved ease of operation under conditions of changing power output demand.

The gas turbine may nominally be designed to be fuelled with gas of higher calorific value than the synthetic fuel gas mixture being supplied to the combustor. For example, the gas turbine may be designed for natural gas operation.

Means may be provided for saturating the fuel gas with water before it is supplied to the combustor (as in CPG systems referenced below), or for injecting nitrogen from the air separation unit into the combustor, either directly or by introduction into the fuel supply, in order to cool the flame, increase power output, and reduce NOx emissions.

The provision of extraction means is particularly advantageous in these arrangements, as a reduced amount of air is required from the compressor flame cooling.

The power generation apparatus may further comprise a second expander, in addition to the gas turbine expander, arranged to receive and expand some or all of the extracted pressurised air. The work of expansion may be recovered and used in a variety of ways, to increase the plant overall efficiency. For

example, the second expander may be arranged to drive an electrical generator to increase the electrical power output of the plant. The generator may be a second, additional generator, or may be the main generator driven by the gas turbine. Thus, the main generator may be arranged to be driven in part by the second expander.

The extraction means may be arranged to extract a substantially constant fraction of the total compressed air output of the compressor.

The extraction means may be arranged such that the amount of air extracted is substantially proportional to the amount of air supplied to the combustor.

The extraction means may be operable to control the amount or proportion of compressed air extracted from the gas turbine.

The extraction means may comprise a fixed or variable extraction orifice.

Means may be provided for controlling the extraction means to reduce the amount or proportion of compressed air extracted in response to rapid increases in power output demand. Response times may therefore be improved as a greater amount or proportion of the air produced by the compressor can be quickly made available for combustion.

The control means may control the extraction means to vary the amount or proportion of compressed air extracted in response to changes in flame temperature, fuel calorific value (resulting, for example, from changes in feedstock), or other factors affecting flame cooling requirements. This further improves the flexibility of the design.

The amount of air extracted can be adjusted to suit the particular combination of fuel gas, the

amount of any additional flame cooling by saturation or nitrogen injection, and compressor design.

According to a second aspect of the present invention there is provided a method for generating power using apparatus comprising a gas turbine having a compressor, a combustion chamber, and an expander arranged to drive the compressor and a generator, the method comprising the steps of:

feeding an oxygen-enriched product from an air separation unit to a gasification vessel;

partially oxidizing a carboniferous feedstock in said gasification vessel to produce synthetic fuel gas;

feeding said synthetic fuel gas into said combustion chamber;

compressing feed air in said compressor;

delivering a first portion of the resultant compressed air from the compressor into said combustion chamber;

combusting said synthetic fuel gas in said combustion chamber to form hot pressurised combustion products;

expanding the hot pressurised combustion products in said expander;

extracting from the gas turbine a second portion of said resultant compressed air; and

not feeding said second portion to the air separation unit.

Embodiments of the present invention will now be described with reference to the accompanying drawings in which:

Fig. 1 is a schematic diagram of an Integrated Gasification Combined Cycle (IGCC) power generation facility in accordance with the prior art;

Fig. 2 is a schematic diagram of a Gasification

Combined Cycle (GCC) power generation facility embodying the present invention;

Fig. 3 is a schematic diagram of a Clean Power Generation (CPG) facility in accordance with the prior art; and

Fig. 4 is a schematic diagram of a clean power generation facility embodying the present invention.

Fig. 5 is a highly schematic diagram of alternative air extraction arrangements for use in embodiments of the present invention; and

As mentioned above, the present invention enables modern gas turbines with very high efficiency compressors having low surge margins to be used in gasification power generation apparatus. Use of such high efficiency compressors coupled with power generation from the expansion of extracted air can lead to significant increases in the overall efficiency of the power generation process compared with arrangements in which excess air is swallowed rather than being extracted. For example, in one feasibility study, the overall efficiency of a known system using an older compressor, able to swallow the excess air (ie. having an adequately large surge margin), and from which no air was extracted, was found to be 39.8%. In contrast, the overall efficiency of a corresponding embodiment of the present invention was found to be 41.8%, a significant 2% improvement. In this embodiment, a more modern gas turbine with a higher efficiency compressor (and smaller surge margin) was used, and 10% of the compressed air produced by the compressor was extracted and expanded in an expander driving a generator. The modern compressor design was such that without the 10% air extraction it would have choked or stalled, ie. it could not swallow the excess air. The

use of the high efficiency, modern gas turbine required a 10% blow-off from the compressor section in order to prevent surging when cutting back air to maintain gas turbine expander inlet temperature (ie. flame temperature).

Fig. 6 is a more detailed schematic diagram of the air extraction arrangement in an embodiment of the present invention.

In the embodiment shown in Fig. 2, the gas turbine expander 12 and heat recovery steam generator 6 drive an electrical generator 20, and excess air produced by the gas turbine compressor 11 is directed away from the combustor 13, i.e. the excess air is extracted from the gas turbine 1. The extracted compressed air 112 is expanded in an air expander 4, arranged to drive an electrical generator 41. In addition to providing the advantages associated with surplus air extraction described above, this arrangement also enables the overall electrical power output of the plant to be increased.

Even after expansion, the extracted air is not fed to the air separation unit, which at all times has an independent air feed 53. Oxygen-rich product stream 51 from the air separation unit is supplied to the gasifier 3 for the gasification of the feedstock.

The arrangement of Fig. 2 also includes a gas clean-up plant, primarily for reducing the sulphur content of fuel gas supplied into the combustor, which reduces the amount of undesirable environmental emissions.

Fig. 3 shows a known variant of a gasification combined cycle process offering high efficiency and extremely good environmental performance. This arrangement is known as the Clean Power Generation (CPG) system and is the subject of Patents

Nos. EP-B-0384781 and GB-B-2234984. CPG is advantageous to the Gasification Combined Cycle process in that it allows for the energy lost to the process when using a quench gasifier, as opposed to a boiler design, to be recovered. The latter results in a higher overall capital cost and a taller gasifier structure, and can also introduce additional operational problems associated with particulate buildup and acid deposition.

In the CPG system the quench gasifier 3 is operated at high pressure to improve the efficiency of the gasification process. Higher pressure also improves heat transfer in the downstream heat exchangers, as the fuel gas is more dense.

Before the fuel gas is supplied to the gas turbine 1 it is saturated in a saturater vessel. This addition of water helps to cool the combustor flame and enables extremely low NOx emission levels to be achieved. Water addition can also increase gas turbine power output owing to an increase in the mass of gas passing through.

Saturating the fuel gas does, however, exaggerate the effects of excess air from the compressor section of the gas turbine. It can be thought of as diluting the fuel gas, in effect reducing its calorific value. Thus, application of the present invention is particularly advantageous in CPG systems.

An example of such an arrangement is shown in Fig. 4. As mentioned above, in CPG the gasification takes place at high pressure. The saturater is not a high pressure vessel however, and the pressure of fuel gas from the gasifier must first be reduced. This pressure reduction is typically achieved in a dry gas expander arranged to drive an electrical generator, to recover the work of expansion and increase the overall

efficiency of the process. Conveniently, in the embodiment shown in Fig. 4, the surplus air extracted from the gas turbine is expanded in an expander 4 fitted on the same shaft as the dry gas expander, and drives the same generator 41.

Referring now to Fig. 5a, in certain embodiments of the present invention air may be extracted 112 from an intermediate stage of the compressor 11. In alternative arrangements, as shown in Fig. 5b, compressed air may be extracted 112 at a point between the output of the final stage of the compressor 11 and the air inlet to the combustor 13.

Fig. 6 shows one such arrangement in greater detail. In this example the total compressed air output 113 from the compressor 11 enters a chamber 90. A first portion 111 of this compressed air enters the combustion chamber 13 via the air inlet orifice 131 and the remaining portion 112 is diverted and extracted from the gas turbine. The extraction means includes a control valve 80 which can be adjusted to vary the amount of extracted air and the ratio of the extracted portion 112 to the portion entering the combustor.

Fig. 6 shows all of the compressor output 113 exiting the chamber 90 either in the combustor portion 111 or in the extracted portion 112. This corresponds to the steady state condition. However, under transient conditions the “capacity” of the chamber 90 may mean that the flow of air into the chamber does not match the flow out of it. If there is a large mismatch between the compressor output capability and the flow of compressed air 111 into the combustor, then with control valve 80 closed there may be a large increase in pressure in the chamber 90. In this situation, the pressure increase may be sufficient to

stall the compressor 11 but will at least result in additional heating of the air in the chamber 90.

CLAIMS

1. Power generation apparatus comprising:

a generator;

a gas turbine comprising a combustor, a compressor having an air feed and being operable to produce compressed air from said air feed, means for delivering a portion of said compressed air into the combustor, and an expander arranged to receive hot combustion products from the combustor and to drive the compressor and the generator with work produced from the expansion of the hot combustion products;

extraction means for extracting from the gas turbine a remaining portion of said compressed air;

fuel gas supply means for supplying fuel gas to the combustor, including a gasification vessel inside which fuel gas is produced by the partial oxidation of a carboniferous feedstock;

an air separation unit operable to produce an oxygen-enriched product from a compressed air feed and arranged to supply at least a portion of said oxygen-enriched product to the gasification vessel for said partial oxidisation; and

air compression means, independent of the gas turbine compressor, arranged to provide said compressed air feed to the air separation unit,

the power generation apparatus comprising no means for feeding compressed air extracted from the gas turbine to the air separation unit.

2. Power generation apparatus in accordance with claim 1, wherein said gas turbine is nominally designed to be fuelled with gas having a higher calorific value than the fuel gas supplied to said combustor.

3. Power generation apparatus in accordance with claim 1 or claim 2, wherein said gas turbine is nominally designed to be fuelled with natural gas.

4. Power generation apparatus in accordance with any preceding claim further comprising means for saturating the fuel gas before it is supplied to the combustor.

5. Power generation apparatus in accordance with any preceding claim further comprising means for injecting nitrogen from the air separation unit into the combustor.

6. Power generation apparatus in accordance with any preceding claim further comprising a second expander arranged to receive at least a part of the remaining portion of compressed air extracted from the gas turbine, and work recovery means for recovering work produced from the expansion of said extracted air in the second expander.

7. Power generation apparatus in accordance with claim 6, wherein said work recovery means comprises generating means arranged to be driven by the second expander.

8. Power generation apparatus in accordance with any preceding claim, wherein said extraction means is arranged to extract a substantially constant fraction of the total compressed air production of the compressor.

9. Power generation apparatus in accordance with any preceding claim, wherein said extraction means is

arranged to extract a portion of the compressed air substantially proportional to the portion of compressed air delivered into the combustor.

10. Power generation apparatus in accordance with any preceding claim, wherein said extraction means is controllable to vary the amount of compressed air extracted from the gas turbine.

11. Power generation apparatus in accordance with claim 10 further comprising control means for controlling said extraction means, the control means being responsive to at least one of power demand and combustor flame temperature.

12. A Gasification Combined Cycle power generation facility comprising power generation apparatus in accordance with any preceding claim.

13. A Clean Power Generation (CPG) facility comprising power generation apparatus in accordance with any one of claims 1-11.

14. A Clean Power Generation facility comprising power generation apparatus in accordance with any one of claims 7-11, comprising a dry gas expander arranged to reduce the pressure of fuel gas from the gasification vessel before the fuel gas enters a saturater vessel, wherein said dry gas expander is arranged to drive said second generator.

15. A method for generating power using apparatus comprising a gas turbine having a compressor, a combustion chamber, and an expander arranged to drive the compressor and a generator, the method comprising

the steps of:

feeding an oxygen-enriched product from an air separation unit to a gasification vessel;

partially oxidizing a carboniferous feedstock in said gasification vessel to produce synthetic fuel gas;

feeding said synthetic fuel gas into said combustion chamber;

compressing feed air in said compressor;

delivering a first portion of the resultant compressed air from the compressor into said combustion chamber;

combusting said synthetic fuel gas in said combustion chamber to form hot pressurised combustion products;

expanding the hot pressurised combustion products in said expander;

extracting from the gas turbine a second portion of said resultant compressed air; and

not feeding said second portion to the air separation unit.

16. A method for generating power in accordance with claim 15 further comprising the step of expanding at least some of said second portion in a second expander arranged to drive a generator.

17. A method for generating power in accordance with claim 15 or claim 16 further comprising the step of controlling the quantity of said resultant compressed air extracted from the gas turbine.

18. Power generation apparatus substantially as hereinbefore described with reference to Figures 2, 4, 5 and 6 of the accompanying drawings.

19. A Gasification Combined Cycle power generation facility substantially as hereinbefore described with reference to Figures 2, 4, 5 and 6 of the accompanying drawings.

20. A Clean Power Generation facility substantially as hereinbefore described with reference to Figures 2, 4, 5 and 6 of the accompanying drawings.

21. A method for generating power substantially as hereinbefore described with reference to Figures 2, 4, 5 and 6 of the accompanying drawings.